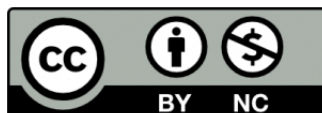




Universidade de Brasília

Repositório Institucional da Universidade de Brasília

repositorio.unb.br



Este artigo está licenciado sob uma licença Creative Commons Atribuição-NãoComercial 4.0 Internacional.

Você tem direito de:

Compartilhar — copiar e redistribuir o material em qualquer suporte ou formato.

Adaptar — remixar, transformar, e criar a partir do material.

De acordo com os termos seguintes:

Atribuição — Você deve dar o **crédito apropriado**, prover um link para a licença e **indicar se mudanças foram feitas**. Você deve fazê-lo em qualquer circunstância razoável, mas de maneira alguma que sugira ao licenciante a apoiar você ou o seu uso

Não Comercial — Você não pode usar o material para **fins comerciais**.

Sem restrições adicionais — Você não pode aplicar termos jurídicos ou **medidas de caráter tecnológico** que restrinjam legalmente outros de fazerem algo que a licença permita.



This article is licensed under a Creative Commons Attribution-NonCommercial 4.0 International License.

You are free to:

Share — copy and redistribute the material in any medium or format.

Adapt — remix, transform, and build upon the material.

Under the following terms:

Attribution — You must give **appropriate credit**, provide a link to the license, and **indicate if changes were made**. You may do so in any reasonable manner, but not in any way that suggests the licensor endorses you or your use.

NonCommercial — You may not use the material for **commercial purposes**.

No additional restrictions — You may not apply legal terms or technological measures that legally restrict others from doing anything the license permits.

Esta licença está disponível em: <https://creativecommons.org/licenses/by-nc/4.0/>



Shrimp and conventional U-Pb age, Sm-Nd isotopic characteristics and tectonic significance of the K-rich Itapuranga suite in Goiás, Central Brazil

MÁRCIO M. PIMENTEL¹, ELTON L. DANTAS¹, REINHARDT A. FUCK¹
and RICHARD A. ARMSTRONG²

¹Laboratório de Geocronologia, Instituto de Geociências, Universidade de Brasília
70910-900 Brasília, DF

²Research School of Earth Sciences, Australian National University
Canberra, ACT 0200 Austrália

*Manuscript received on June 4, 2002; accepted for publication on January 2, 2003;
contributed by MÁRCIO M. PIMENTEL* and REINHARDT A. FUCK**

ABSTRACT

The Itapuranga alkali granite and Uruana quartz syenite are large K-rich EW-elongated intrusions, in the central part of the Neoproterozoic Brasília Belt, central Brazil. They are associated with Pireneus lineaments, which cut the regional NNW-SSE structures of the southern part of the belt.

SHRIMP and conventional U-Pb data for the Itapuranga and Uruana intrusions indicate crystallization ages of 624 ± 10 Ma and 618 ± 4 Ma, respectively. Three zircon cores from the Itapuranga granite yielded U-Pb ages between 1.79 and 1.49 Ga. Sm-Nd T_{DM} ages for both intrusions are 1.44 Ga and $\epsilon_{Nd}(T)$ values are -5.1 and -5.7 , suggesting the input of material derived from older (Paleo- to Mesoproterozoic) sialic crust in the origin of the parental magmas.

Magma mixing structures indicate co-existence of mafic and felsic end-members. The felsic end-member of the intrusions is dominantly represented by crust-derived melts, formed in response to the invasion of Paleo/Mesoproterozoic sialic crust by alkali-rich mafic magmas at ca. 620 Ma.

These intrusions are roughly contemporaneous with, or perhaps slightly younger than, the peak of regional metamorphism in the southern Brasília Belt. Their emplacement along the Pireneus lineament suggest a syn-tectonic origin for them, most probably in transtensional settings along these faults.

Key words: Brasília Belt, Brasiliano, Itapuranga, Uruana, U-Pb SHRIMP, Pireneus Syntaxis.

INTRODUCTION

The Brasília Belt is part of a large Neoproterozoic (Brasiliano/Pan African) orogen developed between the Amazon and São Francisco cratons in central Brazil (Figure 1). It is formed by ca. 1.0 Ga-0.6 Ga old sedimentary units in its eastern part, and by a

large juvenile, ca. 0.9-0.64 Ga magmatic arc in the west (for a review, see Pimentel et al. 2000 and Dardenne 2000). Archean and Paleoproterozoic terrains are exposed in the central part of the belt. The Goiás Archean Block (Figure 1), for example, is located to the west of an important gravimetric anomaly (Marangoni et al. 1995) suggestive of a Neoproterozoic suture zone, and is, therefore interpreted as an allochthonous block, amalgamated to the Brasília

*Member of Academia Brasileira de Ciências
Correspondence to: Márcio M. Pimentel
E-mail: marcio@unb.br / mmp1103@terra.com.br

orogen during the Neoproterozoic (Pimentel et al. 2000). The Almas-Conceição do Tocantins Paleoproterozoic Block (Figure 1) is interpreted as an extension of the sialic terrains exposed within the northwestern part of the São Francisco Craton and represents, therefore, an autochthonous exposure of the sialic basement of the Brasília Belt sediments.

Metamorphism increases from lower greenschist facies in the east to granulite facies in the central part of the belt. Granulites underlie large areas and constitute an important portion of the Barro Alto, Niquelândia and Cana Brava layered mafic-ultramafic complexes, in the northern part of the belt, and also of the Anápolis-Itaçu Complex, in the south (Figure 1). High-grade metamorphic rocks have been dated at ca. 780-760 Ma in the northern mafic granulites (Ferreira Filho et al. 1994, Correia et al. 1997, Pimentel et al. 2001), and at ca. 620-640 Ma in the Anápolis-Itaçu Complex (Fischel et al. 1998, 2001a) (Figure 1). The peak of metamorphism at the end of the Neoproterozoic was shortly followed by, or was concomitant with uplift, erosion and extensive mafic magmatism, especially in the western and central parts of the belt (Pimentel et al. 1996, Hollanda et al. 2002).

One of the most conspicuous structural features of the Brasília Belt is the approximately EW lineaments that occur in its central and southern parts, some of which have been interpreted as lateral ramps related to the important eastward mass transport in the southern part of the belt (Strieder and Suita 1999, Araújo Filho 2000). The Pireneus lineament is the most obvious of these structures, and extends for over 200 km roughly in the EW direction, marking the so-called Pireneus Syntaxis (Araújo Filho 2000). The latter is defined as a concave to foreland curve of the Brasília Belt, interpreted as the result of interference between two structurally different belts: one to the north (northern Brasília Belt) with NNE structural trend and one to the south of the systaxis (southern Brasília Belt), with NNW-trending structures (Araújo Filho 2000). Some of the alkali rich granitoids and quartz syenitic rocks such as the Ita-

puranga granite and Uruana syenite (known collectively as the Itapuranga Suite, Oliveira 1997) intrude along these E-W lineaments and may be interpreted as syn- or late-tectonic. Their emplacement age and tectonic significance have been a matter of debate.

In this paper we present new conventional and SHRIMP U-Pb data, as well as Sm-Nd isotopic results for these rocks, and discuss their significance in relation to the timing of development of the EW faults associated with the Pireneus Syntaxis.

GEOLOGICAL SETTING

The Pireneus Lineament and the Itapuranga and Uruana intrusions are located in the central part of the Brasília Belt, between two large Neoproterozoic granulite belts (Figure 1). The granulite belt in the north is made of three Paleo- to Mesoproterozoic mafic-ultramafic layered complexes (Barro Alto, Niquelândia and Cana Brava) extending for more than 300 km in the NE direction. They are formed by high grade mafic and ultramafic rocks in their eastern part, which have been dated at ca. 2.0 Ga (U-Pb data of Correia et al. 1997) and amphibolite facies rocks in the west (Ferreira Filho et al. 1998), which were dated at ca. 1.3 Ga (Sm-Nd data of Ferreira Filho and Pimentel 2000). These bodies have been interpreted as layered intrusions formed in a continental setting during the Meso- of Paleoproterozoic which have been metamorphosed at granulite facies during the Neoproterozoic. High grade metamorphism in these complexes has been dated by conventional and SHRIMP U-Pb methods and also by Sm-Nd garnet-whole rock isochrons, at ca. 760-780 Ma (Ferreira Filho et al. 1994, Suita et al. 1994, Correia et al. 1997, Moraes et al. 2000, Pimentel et al. 2001). A lower grade metamorphic event at ca. 620 Ma also affected these rocks, as indicated by the rutile and garnet U-Pb and Sm-Nd isotopic data of Ferreira Filho et al. (1994) and Ferreira Filho and Pimentel (2000). Granulitic rocks to the south of the study area are included in the Anápolis-Itaçu Complex, which is exposed in a large NNW-elongated area between metasediments

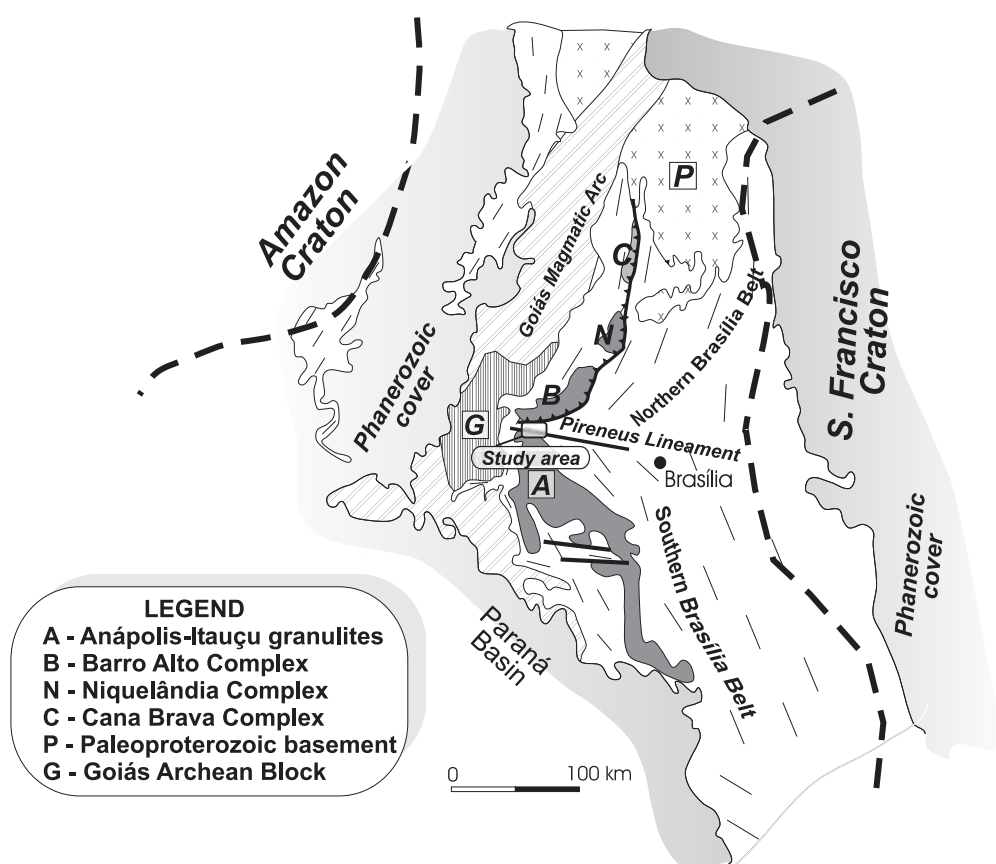


Fig. 1 – Geological sketch map of the eastern part of the Tocantins Province.

(mostly metapelites) of the Neoproterozoic Araxá Group. Rock types of different nature constitute the complex, including: (i) orthogranulites represented by mafic-ultramafic layered bodies, as well as granulites of tonalitic and granodioritic compositions, (ii) aluminous granulites, leptynites and garnet gneisses associated with supracrustal rocks such as marble, calcsilicate rocks, quartzite and fine grained amphibolites, (iii) narrow strips of Neo- and Paleoproterozoic volcano-sedimentary sequences made of amphibolite, micaschist, felsic metavolcanic, metachert and iron formation (e.g. Silvânia, Bonfinópolis and Rio do Peixe sequences; Araújo Filho 1981, Lacerda Filho and Oliveira 1995), and (iv) a large number of granitoid intrusions forming NW-SE elongated bodies. SHRIMP U-Pb results (Fischel et al. 2001a) show that most of the granitoid

rocks are Neoproterozoic, ranging in age between ca. 650 and 620 Ma.

Fischel et al. (1998, 2001a) have demonstrated that the high grade metamorphic event happened at the end of the Neoproterozoic, during the Brasiliano orogeny, and is at least 140 Ma younger than the high grade metamorphism in the northern part of the belt.

THE ITAPURANGA AND URUANA INTRUSIONS

The Itapuranga and Uruana bodies are exposed just to the north of the Anápolis-Itauçu high-grade complex and are intrusive into orthogneisses of unknown age, supracrustal rocks of the possibly Paleoproterozoic Rio do Peixe volcano-sedimentary sequence and also into metasediments of the Araxá Group and Serra Dourada Sequence (Figure 2). In gen-

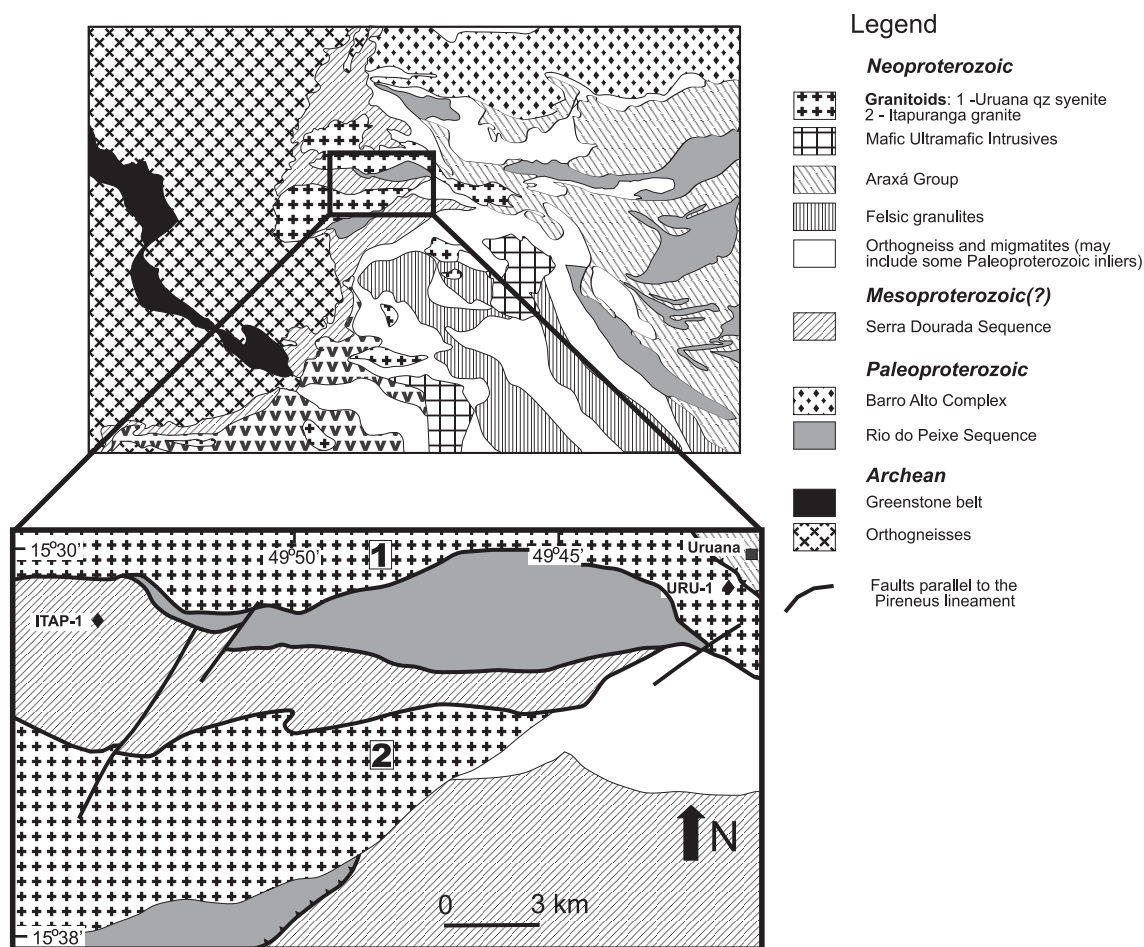


Fig. 2 – Simplified geological map of the Itapuranga-Uruana area (sheet SD.22-Z-C-VI), adapted from Oliveira (1997).

eral, the contacts between the intrusions and the country-rocks are marked by mylonitic zones and cross-cutting relationships are rarely observed.

In the study area, the Rio do Peixe volcano-sedimentary sequence is formed by amphibolite, calc-silicate rock, and micaschist with garnet and staurolite. Less abundant felsic metavolcanics have also been described (Oliveira 1997). This sequence has been traditionally correlated with the Silvânia metavolcanics, exposed to the southeast of the area, and dated recently at ca. 2.1 Ga (Fischel et al. 2001b). The Araxá Group is formed dominantly by pelitic schists with garnet and thin quartzite layers, and the Serra Dourada Sequence, of unknown age, comprises quartz schist and quartzite.

The Uruana and Itapuranga intrusions are part of an extended suite (Itapuranga Suite) comprising mainly quartz syenite, alkali granite, with less abundant quartz monzonite, quartz diorite, granodiorite and tonalite (Souza et al. 1993, Lacerda Filho and Oliveira 1995, Oliveira 1997). They form large intrusions elongated in the E-W direction, emplaced mainly into metasediments of the Brasília Belt.

The Uruana and Itapuranga bodies are petrographically and structurally very similar to each other. They present a pervasive EW to WNW foliation which becomes progressively better developed towards the margins of the intrusions. Mylonitic, protomylonitic and augen textures are common and ultramylonites have been described in some places

(Oliveira 1997). The intrusions comprise medium- to coarse-grained quartz syenites, alkali granites, which are largely dominant over quartz monzonites, granodiorites, tonalities and quartz diorites. Primary mineralogy includes K-feldspar, plagioclase, quartz, biotite, hornblende, riebeckite and clinopyroxene (Lacerda Filho and Oliveira 1995). Round to elongated mafic enclaves are not rare and suggest that mixing between mafic and felsic magmas took place during the origin of the plutons. The presence of blue amphibole and aerigine in these mafic enclaves suggests an original alkaline nature for the basic end-member (Oliveira 1997).

The general geochemical features reveal the alkaline nature of the magmatism. According to Souza et al. (1993) and Oliveira (1997), major and trace element composition of the Itapuranga and Uruana granite and quartz syenite bear similarities with rocks of the shoshonite clan. The high contents of Nb, Y, Rb and Zr are similar to those found in within plate granites (Oliveira 1997).

MATERIALS AND METHODS

ANALYTICAL PROCEDURES

Zircon concentrates were extracted from ca. 10 kg rock samples, using conventional gravimetric (DENSITEST®) and magnetic (Frantz isodynamic separator) techniques at the Geochronology Laboratory of the University of Brasília. Final purification was achieved by hand picking using a binocular microscope.

For the conventional U-Pb analyses, fractions were dissolved in concentrated HF and HNO₃ (HF:HNO₃ = 4:1) using microcapsules in Parr-type bombs. A mixed ²⁰⁵Pb-²³⁵U spike was used. Chemical extraction followed standard anion exchange technique, using Teflon microcolumns, following procedures modified from Krogh (1973). Pb and U were loaded together on single Re filaments with H₃PO₄ and Si gel, and isotopic analyses were carried out on a Finnigan MAT-262 multi-collector mass spectrometer equipped with secondary electron multiplier - ion counting, at the Geochronology Labora-

tory of the University of Brasília. Procedure blanks for Pb, at the time of analyses, were better than 50 pg. PBDAT (Ludwig 1993) and ISOPLOT-Ex (Ludwig 2001a) were used for data reduction and age calculation. Errors for isotopic ratios shown in Table II are 2σ. Ion microprobe analyses were carried out using SHRIMP I at the Research School of Earth Sciences, Australian National University, Canberra, Australia. Zircon grains were mounted in epoxy resin and polished. Transmitted and reflected light microscopy, as well as scanning electron microscope cathodoluminescence imagery was used to investigate the internal structures of the zircon crystals prior to analysis. Data were collected and reduced as described by Williams and Claesson (1987) and Compston et al. (1992). Uncertainties reported in Table I are given at 1 σ level, and final age quoted at 95% confidence level. Reduction of raw data was carried out using Squid 1.02 (Ludwig 2001b). U/Pb ratios were referenced to the RSES standard zircon AS3 (1099 Ma, *²⁰⁶Pb/²³⁸U = 0.1859, Paces and Miller 1993). U and Th concentrations were determined relative to those measured in the RSES standard SL13. All errors quoted in Table I are 1σ, but error for concordia age of sample ITAPU-1 is quoted within 95% confidence limits.

Sm-Nd isotopic analyses followed the method described by Gioia and Pimentel (2000) and were carried out at the Geochronology Laboratory of the University of Brasília. Whole rock powders (ca. 50 mg) were mixed with ¹⁴⁹Sm-¹⁵⁰Nd spike solution and dissolved in Savillex capsules. Sm and Nd extraction of whole-rock samples followed conventional cation exchange techniques, using Teflon columns containing LN-Spec resin (HDEHP – diethylhexil phosphoric acid supported on PTFE powder). Sm and Nd samples were loaded on Re evaporation filaments of double filament assemblies and the isotopic measurements were carried out on a multi-collector Finnigan MAT 262 mass spectrometer in static mode. Uncertainties for Sm/Nd and ¹⁴³Nd/¹⁴⁴Nd ratios are better than ±0.4% (1σ) and ±0.005% (1σ) respectively, based on repeated anal-

yses of international rock standards BHVO-1 and BCR-1. $^{143}\text{Nd}/^{144}\text{Nd}$ ratios were normalized to $^{146}\text{Nd}/^{144}\text{Nd}$ of 0.7219 and the decay constant used was $6.54 \times 10^{-12} \text{ a}^{-1}$. T_{DM} values were calculated using DePaolo's (1981) model.

ISOTOPIC RESULTS AND DISCUSSION

U-Pb isotopic results for samples ITAPU-1 and URU-1 are in Tables I and II, respectively. Morphology of the zircon grains in both samples is very homogeneous, and all grains analyzed are prismatic, pink, and free of inclusions and cracks. Sm-Nd isotopic analyses were carried out for the same samples of the Itapuranga and Uruana intrusions and the results are shown in Table III.

Zircon grains in sample ITAPU-1 are pink, prismatic and stubby. Some of them present inherited cores, which are obvious in the cathodoluminescence images, surrounded by overgrowths displaying oscillatory zoning. As the main objective of the study was to assess the age of igneous crystallization, most of the analyses were carried out on igneous rims and not on the inherited nuclei. Nevertheless, three SHRIMP U-Pb analyses of cores yielded concordant to sub-concordant results with $^{207}\text{Pb}/^{206}\text{Pb}$ age of ca. 1790, 1759 and 1491 Ma (Figure 3a), indicating Paleoproterozoic and Mesoproterozoic inheritance. Magmatic overgrowths and individual igneous crystals present typical oscillatory zoning and resulted in concordant analyses allowing the calculation of the concordia age (Ludwig 1998) of $624 \pm 10 \text{ Ma}$ (probability of concordance of 0.87) for 11 concordant analytical points (Figure 3b). This represents the best estimate for the age of crystallization of the Itapuranga alkali granite.

Zircon crystals in the Uruana syenite are very similar to those from the Itapuranga granite. Only clear, prismatic grains, without visible cores under a binocular microscope were selected for analysis. Conventional U-Pb results for five fractions are in Figure 3c. Fractions URU-1.1, URU-1.2 and URU-1.3 define a discordia indicating the upper intercept age of $648 \pm 7 \text{ Ma}$. However, it is likely that frac-

tions 2 and 3 contain a small inherited component, or alternatively have been under-corrected for the presence of common lead. Fractions 4 and 5 indicate much younger $^{207}\text{Pb}/^{206}\text{Pb}$ ages (626 and 612 Ma). A regression line through fractions 1, 4 and 5 results in an upper intercept age of $618 \pm 4 \text{ Ma}$ (2σ), which agrees, within uncertainty, with the SHRIMP U-Pb zircon age of the Itapuranga granite. This is taken here, therefore, as the best estimate for the age of crystallization of the Uruana syenite. U-Pb data, therefore, indicate that the Uruana and Itapuranga intrusions crystallized roughly at the same time, at ca. 620 Ma, at the final stages of the Brasiliano event, in central Brazil.

Sm-Nd isotopic analysis for samples ITAPU-1 and URU-1 show that both rock samples are rich in LREE, have low Sm/Nd ratios and negative $\epsilon_{\text{Nd}}(T)$ values (-5.1 and -5.7). Therefore, the Sm-Nd isotopic data also indicate contribution of older sialic crust to the Uruana and Itapuranga parental magmas. TDM model ages of 1.44 Ga for both rock units most probably represent mixed ages between a mantle-derived Neoproterozoic component and a Paleoproterozoic (and Mesoproterozoic?) crustal contaminant. Together with field evidence, which indicate mixing of mafic and felsic magmas, the Nd isotopic data suggest that partial melting of Paleo- or Mesoproterozoic sialic lower crust occurred due to the emplacement of hot mantle-derived mafic magmas. Intermediate facies of these intrusions, including quartz diorite, tonalite and granodiorite are not voluminous, and might represent, therefore, local products of mixing between mafic and felsic end-members.

CONCLUSIONS

Conventional and SHRIMP U-Pb ages of the Uruana and Itapuranga quartz syenite and alkali granite intrusions indicate that they are roughly coeval and have crystallized at $624 \pm 10 \text{ Ma}$ and $618 \pm 4 \text{ Ma}$, respectively. They are contemporaneous with, or perhaps, slightly younger than the peak of regional metamorphism of the Brasiliano orogenic event in

TABLE I

Summary of SHRIMP U-Th-Pb isotopic data for the Itapuranga granite.

Grain spot	(1) % ²⁰⁶ Pb _c	ppm U	ppm Th	²³² Th / ²³⁸ U	ppm Rad 206Pb	(1) ²⁰⁶ Pb/ ²³⁸ U Age	1σ err	(1) ²⁰⁷ Pb/ ²⁰⁶ Pb Age
ITAPU1-1.1r	1.76	1830	123	0.07	159.2	611.3	15.2	603
ITAPU1-1.2c	0.45	234	174	0.77	63.9	1772.4	41.3	1759
ITAPU1-2r	0.55	308	229	0.77	26.2	605.2	16.1	457
ITAPU1-3.1c	0.29	50	38	0.80	12.7	1677.1	43.9	1790
ITAPU1-3.2r	0.23	658	274	0.43	58.0	628.4	15.8	554
ITAUP1-4.1r	0.07	376	131	0.36	32.4	615.4	15.8	602
ITAPU1-5.1r	1.30	198	48	0.25	15.5	556.7	15.1	488
ITAPU1-5.2r	0.09	761	325	0.44	67.4	631.8	15.8	645
ITAPU1-6.1r	0.03	317	232	0.76	28.4	639.2	16.6	641
ITAPU1-7r	2.86	387	303	0.81	37.2	664.6	20.6	-217
ITAPU1-8r	-0.14	258	123	0.49	23.5	650.9	16.9	639
ITAPU1-9.1r	0.19	122	60	0.51	10.1	595.1	17.3	600
ITAPU1-9.2r	-0.10	822	386	0.49	68.9	600.3	16.7	677
ITAPU1-10.1r	0.17	223	147	0.68	19.4	620.0	20.0	607
ITAPU1-11.1c	-0.10	212	65	0.32	44.2	1401.8	34.4	1491
ITAPU1-11.2r	0.04	1585	339	0.22	143.9	647.3	16.1	613
Grain spot	1σ err	% Discor- dant	(1) ²⁰⁷ Pb* / ²⁰⁶ Pb*	% err	(1) ²⁰⁷ Pb* / ²³⁵ U	% err	²⁰⁶ Pb* / ²³⁸ U	% err
ITAPU1-1.1r	112	-1	.0600	5.2	0.82	5.8	.0995	2.6
ITAPU1-1.2c	28	-1	.1076	1.5	4.69	3.1	.3164	2.7
ITAPU1-2r	75	-24	.0561	3.4	0.76	4.4	.0984	2.8
ITAPU1-3.1c	52	7	.10194	2.8	4.48	4.1	.2971	3.0
ITAPU1-3.2r	50	-12	.0586	2.3	0.83	3.5	.1024	2.6
ITAUP1-4.1r	48	-2	.0599	2.2	0.83	3.5	.1002	2.7
ITAPU1-5.1r	189	-12	.0569	8.6	0.71	9.0	.0902	2.8
ITAPU1-5.2r	26	2	.0612	1.2	0.87	2.9	.1030	2.6
ITAPU1-6.1r	51	0	.0610	2.4	0.88	3.6	.1042	2.7
ITAPU1-7r	474	-133	.0422	18.9	0.63	19.1	.1086	3.3
ITAPU1-8r	63	-2	.0610	2.9	0.89	4.0	.1062	2.7
ITAPU1-9.1r	103	1	.0599	4.7	0.80	5.6	.0967	3.0
ITAPU1-9.2r	31	13	.0621	1.4	0.84	3.3	.0976	2.9
ITAPU1-10.1r	70	-2	.0601	3.2	0.84	4.7	.1009	3.4
ITAPU1-11.1c	24	6	.0932	1.3	3.12	3.0	.2429	2.7
ITAPU1-11.2r	21	-5	.0603	1.0	0.88	2.8	.1056	2.6

Errors are 1σ; Pbc and Pb* indicate the common and radiogenic portions, respectively. (1) Common Pb corrected using measured ²⁰⁴Pb. Error in Standard calibration is 0.83% (2σ) (not included in above errors, but required when comparing data from different mounts). c = core, r = rim.

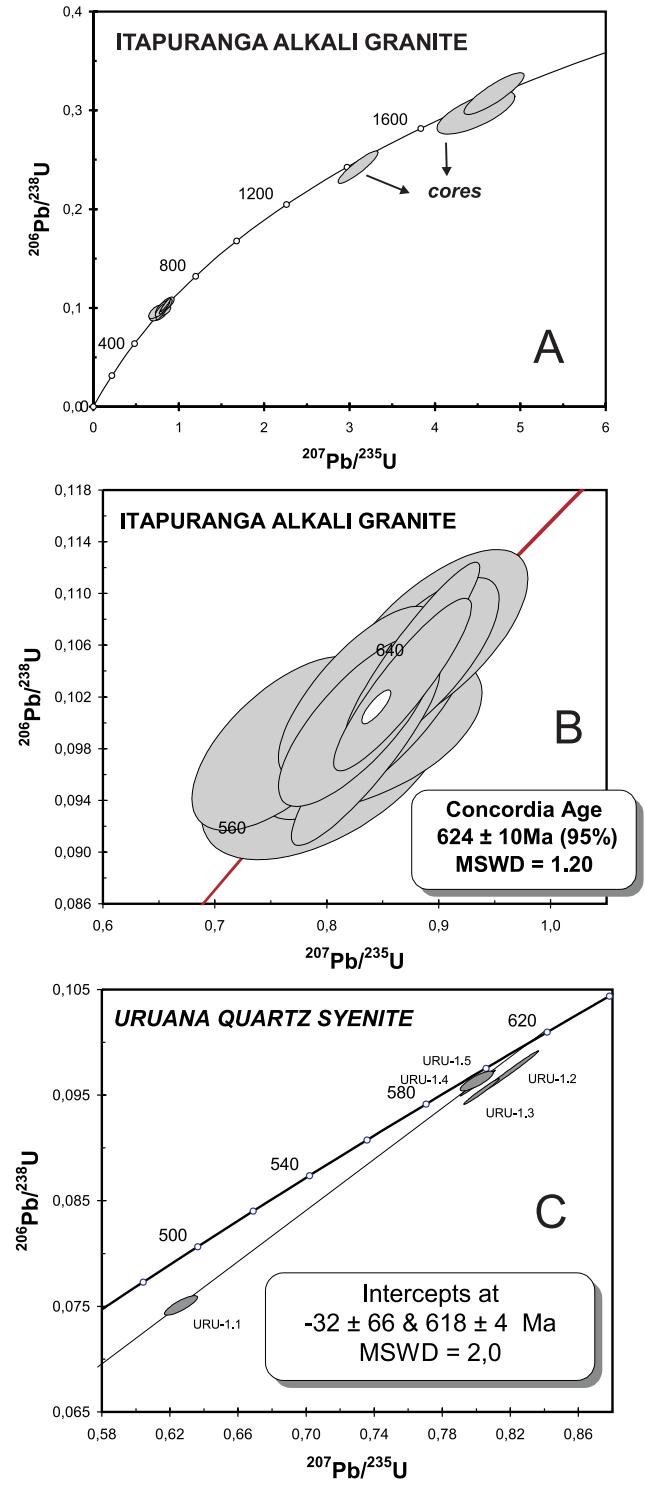


Fig. 3 – U-Pb concordia diagrams for the Itapuranga granite (a and b) and Uruana syenite (c).

TABLE II

U-Pb isotopic data for the Uruana syenite.

Sample Fraction	Size (mg)	U (ppm)	Pb (ppm)	$^{206}\text{Pb}/^{204}\text{Pb}$	$^{207}\text{Pb}/^{235}\text{U}$	(2 σ %)	Pb206* U238
Uru 1.1	0.100	233	25.6	221	0.6315	1.22	0.0755
Uru 1.2	0.134	243	32.9	268	0.8200	1.58	0.0973
Uru 1.3	0.087	241	29.8	411	0.8032	1.05	0.0953
Uru 1.4	0.047	387	46.6	472	0.8014	1.02	0.0962
Uru 1.5	0.014	1630	185	1096	0.8005	0.90	0.0964
Sample Fraction	(2 σ %)	Correl. Coeff. (rho)	Pb207* Pb206*	(pct)	Pb206* U238 Age	Pb207* U235 Age	Pb207* Pb206* Age
Uru 1.1	0.99	0.83	0.0663	0.69	469	497	626
Uru 1.2	1.56	0.992	0.0611	0.18	598	608	643
Uru 1.3	1.03	0.983	0.0611	0.18	587	598	643
Uru 1.4	1.01	0.992	0.0605	0.12	592	598	620
Uru 1.5	0.70	0.840	0.0602	0.40	593	597	612

TABLE III

Sm-Nd isotopic results for the Uruana and Itapuranga intrusions.

Sample	Sm (ppm)	Nd (ppm)	$^{147}\text{Sm}/^{144}\text{Nd}$	$^{143}\text{Nd}/^{144}\text{Nd}$ ($\pm 1\sigma$)	T_{DM} (Ga)	$\varepsilon_{\text{Nd}}(0)$	$\varepsilon_{\text{Nd}}(620)$
URU-1	17.94	109.43	0.0991	0.511949 (10)	1.44	-13.44	-5.72
ITAPU-1	7.960	44.46	0.1082	0.512018 (13)	1.44	-12.10	-5.09

the southern part of the Brasília Belt, as evidenced by SHRIMP U-Pb and Sm-Nd garnet analyses in granulites of the Anápolis-Itaçu Complex (Fischel et al. 1998, 2001a, Pimentel et al. 2001). SHRIMP U-Pb data for zircon cores of the Itapuranga granite indicate inheritance varying in age from ca. 1.79 and 1.49 Ga.

Sm-Nd isotopic data revealed T_{DM} model ages of ca. 1.44 Ga, also indicating, therefore, participation of older (Paleo- to Mesoproterozoic) continental crust in the origin of the parental magma.

Magma mixing features indicating co-existence of mafic and felsic end-members in both the Uruana and Itapuranga intrusions, suggest a mantle derived mafic component in the original magma. Mafic magmatism between ca. 630 and 580 Ma is abundant in the Goiás Magmatic Arc, to the north-west and southwest of the studied area, and have

promoted extensive crustal anatexis during the latest stages of the Brasiliano orogeny in central Brazil (Pimentel et al. 1996, Hollanda et al. 2002). The same scenario can be put forward for the origin of the Uruana and Itapuranga intrusions, in which felsic magmas are mostly derived from, or are heavily contaminated with, older sialic crust, which has been invaded by mafic magmas at the end of the Brasiliano event. This has been interpreted as the product of mantle melting due to adiabatic decompression shortly following the main metamorphic event (Pimentel et al. 1996).

The EW elongation of the Itapuranga and Uruana intrusions and their association with the EW Pireneus lineament suggest that the original magmas ascended through this weakness zone, most probably at transtensional sites. Their age mark, therefore, the age of development of the EW faults, and,

in consequence, of the formation of the Pireneus Syntaxis, as roughly contemporaneous or slightly younger than the peak of Brasiliano metamorphism in the central part of the Brasília Belt.

Regionally, the new geochronological data indicate that granite intrusions emplaced along the common EW faults in the NNW part of the southern Brasília Belt, represent late-orogenic granite magmatism linked with the development of these lateral ramps which in turn are associated to the important thrust sheets in the Araxá Group.

ACKNOWLEDGMENTS

The authors are grateful to CNPq (grants 42.0081-99-2, 46.0408/00-2 to RAF) and FAP-DF (grant 193.000.068/96 to RAF) for financial support for field and laboratory work. The authors also thank two anonymous referees for their helpful comments and suggestions.

RESUMO

O alcali-granito de Itapuranga e o quartzo-sienito de Uruana são corpos alongados na direção E-W na porção central da Faixa Brasília. Eles são associados com o lineamento dos Pireneus, que cortam as estruturas regionais NNW da faixa.

Dados U-Pb (SHRIMP e convencional) para as intrusões de Itapuranga e Uruana indicaram idades de 624 ± 10 Ma e 618 ± 4 Ma, respectivamente. Núcleos de três cristais de zircão do granito Itapuranga têm idades entre 1.79 e 1.49 Ga. Idades modelo Sm-Nd são de 1.44 Ga e valores de $\varepsilon_{Nd}(T)$ são -5.1 e -5.7 , indicando participação de crosta siálica mais antiga (Paleo- a Mesoproterozóica). Feições diagnósticas de mistura de magmas indicam a co-existência de líquidos máficos e félsicos, de forma que os membros-finais félsicos das intrusões possivelmente representam líquidos derivados predominantemente da fusão de crosta continental, formados em resposta à intrusão de magmas máficos de natureza alcalina há ca. 620 Ma.

Essas intrusões são contemporâneas, ou um pouco mais jovens, que o pico metamórfico Brasiliano na porção sul da Faixa Brasília. Seu alojamento ao longo do lineamento

dos Pireneus sugere tratar-se de corpos sin-tectônicos em relação a essas estruturas, tendo os magmas originais cristalizado em zonas de transtensão ao longo das falhas.

Palavras-chave: Faixa Brasília, Brasiliano, Itapuranga, Uruana, U-Pb SHRIMP, Sintaxe dos Pireneus.

REFERENCES

- ARAÚJO-FILHO JO. 1981. Contribuição à estratigrafia e tectônica da Megainflexão dos Pireneus. In: SIMP. GEOLOGIA CENTRO-OESTE, 1., Anais... SBG, Goiânia, p. 24-26.
- ARAÚJO-FILHO JO. 2000. The Pireneus Syntaxis: an example of the intersection of two Brasiliano fold-thrust belts in central Brazil and its implications for the tectonic evolution of western Gondwana. *Rev Bras Geocienc* 30:144-148.
- COMPSTON W, WILLIAMS IS, KIRSCHVINK JL, ZHANG Z AND MA G. 1992. Zircon U-Pb ages for the early Cambrian timescale. *J Geol Soc Lond* 149: 171-184.
- CORREIA CT, TASSINARI CCG, LAMBERT DD, KINNY P AND GIRARDI VAV. 1997. U-Pb (SHRIMP), Sm-Nd and Re-Os systematics of the Cana Brava, Niquelândia and Barro Alto layered intrusions in central Brazil, and constraints on the tectonic evolution. In: SOUTH-AMERICAN SYMPOSIUM ON ISOTOPE GEOLOGY – SSAGI, 1., Extended abstracts... Campos do Jordão, IG-USP, p. 88-89.
- DARDENNE MA. 2000. The Brasília Fold Belt. In: CORDANI UG, MILANI EJ, THOMAZ FILHO A AND CAMPOS DA (eds), *Tectonic Evolution of South America*, Rio de Janeiro, IGC-Rio de Janeiro, p. 231-263.
- DEPAOLO DJ. 1981. A neodymium and strontium isotopic study of the Mesozoic calc-alkaline granitic batholiths of the Sierra Nevada and Peninsular Ranges, California. *J Geophys Res* 86: 10470-10488.
- FERREIRA-FILHO CF AND PIMENTEL MM. 2000. Sm-Nd isotope systematics and REE-Hf-Ta-Th data of troctolites and their amphibolitized equivalents of the Niquelândia Complex Upper Layered Series, central Brazil: further constraints for the timing of magmatism and high-grade metamorphism. *J South Am Earth Sci* 13: 647-659.
- FERREIRA-FILHO CF, KAMO S, FUCHS RA, KROGH TE AND NALDRETT AJ. 1994. Zircon and rutile geochronol-

- ogy of the Niquelândia layered mafic and ultramafic intrusion, Brazil: constraints for the timing of magmatism and high grade metamorphism. *Precamb Res* 68: 241-255.
- FERREIRA-FILHO CF, MORAES R, FAWCETT JJ AND NALDRETT AJ. 1998. Amphibolite to granulite progressive metamorphism in the Niquelândia Complex, central Brazil: regional tectonic implications. *J South Am Earth Sci* 11: 35-50.
- FISCHEL DP, PIMENTEL MM AND FUCK RA. 1998. Idade do metamorfismo de alto grau no Complexo Anápolis-Itaçu, Goiás, determinada pelo método Sm-Nd. *Rev Bras Geocienc* 28: 607-609.
- FISCHEL DP, PIMENTEL MM, FUCK RA AND ARMSTRONG R. 2001a. U-Pb SHRIMP and Sm-Nd geochronology of the Anápolis-Itaçu Complex, Araxá Group and associated granites: Neoproterozoic high grade metamorphism in the central part of the Brasília Belt, Goiás. In: SIMP. SUL-AMERICANO DE GEOLOGIA ISOTÓPICA, SSAGI 3, Pucón, Chile, Extended Abst. Volume CD-ROM... Soc Geol Chile, Santiago, p. 133-136.
- FISCHEL DP, PIMENTEL MM, FUCK RA AND ARMSTRONG RA. 2001b. U-Pb SHRIMP and Sm-Nd geochronology of the Silvânia Volcanics and Jurubatuba Granite: juvenile Neoproterozoic crust in the basement of the Neoproterozoic Brasília Belt, Goiás, central Brazil. *An Acad Bras Cienc* 73: 445-460.
- GIOIA SMCL AND PIMENTEL MM. 2000. The Sm-Nd isotopic method in the Geochronology Laboratory of the University of Brasília. *An Acad Bras Cienc* 72: 219-245.
- HOLLANDA MHB, PIMENTEL MM, ARMSTRONG RA, GIOIA SMCL AND NILSON AA. 2002. Late Brazilian mafic magmatism and crustal re-melting in the Brasília Belt: constraints from SHRIMP U-Pb and Sm-Nd data for late orogenic intrusions. Submitted to *Prec. Research*.
- KROGH TE. 1973. A low-contamination method for hydrothermal decomposition of zircon and extraction of U and Pb for isotopic age determinations. *Geochim Cosmochim Acta* 37: 485-494.
- LACERDA FILHO JV AND OLIVEIRA CC. 1995. Geologia da região centro-sul de Goiás. *Boletim de Geociências do Centro-Oeste*, 18(1/2): 3-19.
- LUDWIG KR. 1993. PBDAT. A computer program for processing Pb-U-Th isotope data. USGS Open File Report 88-542, 34p.
- LUDWIG KR. 1998. On the treatment of concordant uranium-lead ages. *Geochim Cosmoch Acta* 62: 665-676.
- LUDWIG KR. 2001a. Users Manual for Isoplot/Ex version 2.47. A geochronological toolkit for Microsoft Excel. Berkeley Geochronology Center Special Publication 1a, 55pp.
- LUDWIG KR. 2001b. Squid. 1.02. A users manual. Berkeley Geochronology Center Special Publication 2. 19pp.
- MARANGONI YR, ASSUMPÇÃO M AND FERNANDES EP. 1995. Gravimetria no norte de Goiás, Brasil. *Rev Bras Geofis* 13: 205-219.
- MORAES R, GIOIA SMCL, FUCK RA AND PIMENTEL MM. 2000. Relationships between the Barro Alto Complex and Juscelândia Sequence magmatism and metamorphism constrained by Sm-Nd isotopic data. In: INTER GEOL CONGRESS, 31., Abstracts... Rio de Janeiro, CD-ROM.
- OLIVEIRA CC. 1997. Itaguara. Folha SD.22-Z-C-VI 1:100.000. Programa de Levantamentos Geológicos Básicos, CPRM-MME, Brasília, 108p.
- PACES JB AND MILLER JD JR. 1993. Precise U-Pb ages of Duluth Complex and related mafic intrusions, northeastern Minnesota: geochronological insights to physical, petrogenetic, paleomagnetic and tectonomagmatic processes associated with the 1.1 Ga mid-continent rift system. *J Geophys Res* B98: 13997-14013.
- PIMENTEL MM, FUCK RA AND ALVARENGA CJS. 1996. Post-Brazilian (Pan-African) high-K granitic magmatism in central Brazil: late precambrian/early Paleozoic extension. *Precamb Res* 80: 217-238.
- PIMENTEL MM, FUCK RA, JOST H, FERREIRA FILHO CF AND ARAÚJO SM. 2000. The basement of the Brasília Fold Belt and the Goiás Magmatic Arc. In: CORDANI UG, MILANI EJ, THOMAZ FILHO A, CAMPOS DA. (eds.), *The Tectonic Evolution of South America*, Rio de Janeiro, 31st Intern Geol Congress. p. 195-229.
- PIMENTEL, MM, FUCK RA, FISCHEL DP, GIOIA SMCL AND MORAES R. 2001. Two Neoproterozoic high-grade metamorphic events in the Brasília Belt, cen-

- tral Brazil. In: SIMP SUL-AMERICANO DE GEOLOGIA ISOTÓPICA, SSAGI 3, Pucón, Chile, Extended Abst. Volume CD-ROM... Soc Geol Chile, Santiago, p. 205-208.
- SOUZA EC, MARQUES MTG, CAVALCANTE CJ AND CAMARGO MA. 1993. Lithogeochemical panorama of the subalkaline (shoshonitic) Itapuranga Suite, SE Goiás State, central Brazil. In: WORKSHOP MAGMATISMO GRANÍTICO E MINERALIZAÇÕES ASSOCIADAS, 1., Resumos Expandidos... Rio de Janeiro, Acad Bras Ciênc p. 82.
- STRIEDER AJ AND SUITA MTF. 1999. Neoproterozoic geotectonic evolution of Tocantins Structural Province, central Brazil. *J Geodynamics* 28: 267-289.
- SUITA MTF, KAMO SL, KROGH TE, FYFE WS AND HARTMANN LA. 1994. U-Pb ages from the high-grade Barro Alto mafic-ultramafic complex (Goiás, Central Brazil): middle Proterozoic continental mafic magmatism and upper Proterozoic continental collision. In: INTERNATIONAL CONFERENCE ON GEOCRONOLOGY, COSMOCHRONOLOGY AND ISOTOPE GEOLOGY, 7., Abstracts... Berkeley, USGS, p. 309.
- WILLIAMS IS AND CLAEISSON S. 1987. Isotopic evidence for the Precambrian provenance and Caledonian metamorphism of high grade paragneisses from the Seve Nappes, Scandinavian Caledonides. II. Ion microprobe zircon U-Th-Pb. *Contrib Miner Petrol* 97: 205-217.